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UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

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USA BASEBALL, THE NATIONAL HIGH SCHOOL BASEBALL COACHES ASSOCIATION, DR. PETER BERG, JUAN HERNANDEZ, DENNIS CANALE, MEL ZITTER, MICHAEL CRUZ, TITO NAVARRO, JOHN TORRES, EASTON SPORTS, INC., WILSON SPORTING GOODS CO., RAWLINGS SPORTING GOODS COMPANY, and HILLERICH & BRADSBY CO. Plaintiffs, - against - CITY OF NEW YORK, Defendant.	Civil Action No. 07-CV-3605

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DECLARATION OF KEVIN BREEN

I, Kevin Breen, depose and state as follows:

My name is Kevin C. Breen. I am the Principal and Director of Marine and Automotive Research at Breen & Associates/Engineering Systems, Inc. ("ESI"). If sworn as a witness, I could testify competently to the statements in this declaration.

I have more than 25 years' experience in research, testing, and investigation with significant involvement in human factors aspects of recreational activities, including field study of participants. My formal education includes a Master's of Industrial Engineering focus in area of Human Factors. ESI itself is an independent, multi-disciplined firm that provides professional consulting and engineering services involving investigation, research, testing, and related technologies.

<u>Background</u>

ESI has conducted research from a human factors standpoint to evaluate the potential response time of college level baseball pitchers to balls batted in their direction. Included in this research is an analysis to determine the extent to which slower batted ball speeds, allegedly due to bat construction, would affect the pitcher's opportunity to deflect balls rather than being struck.

The following tasks have been conducted as a part of this project.

- A literature search and review of reasonably available, relevant research and studies was conducted. A list of the selected literature located is provided in *Attachment A.*

- A field study was conducted to measure and quantify pitcher response to batted balls in game-like conditions. This study was conducted in a manner that enhanced the analytical precision beyond what would be reasonable to obtain from actual competitive games by selective targeting and measurement/documentation devices. The documentation associated with this field study is shown in *Attachment B.*

A series of videotapes from actual college level games were obtained and analyzed to evaluate and quantify pitcher response to batted balls. In addition, video tapes in situations where pitchers were struck were analyzed to determine available response time, pitcher reactions, and the potential effects of slower batted ball speeds. A listing of the game tapes reviewed is shown in *Attachment C*.

Research

Literature Review

The existing reaction time literature reveals that (a) unprepared subjects take substantially longer (several hundred milliseconds) to react than prepared athletes, and (b) prepared athletes can react very quickly to batted balls, more quickly than necessary for reasonable estimates of batted ball speed. A significant area that has benefited from reaction time study is the automotive area. This has been a topic of research and study for many decades. Though there are obviously significant differences in the reaction/response time models for automobile drivers compared to baseball pitchers some useful concepts are of value.

Typical real-world automotive responses involve the driver transitioning from a relaxed, possibly inattentive state to deal with a hazard. The driver may be involved in conversation with other occupants, looking at the roadside scenery, or simply “day-dreaming” for an extended time period preceding the need to react/respond. By contrast, a baseball pitcher and other athletes are typically constantly focused on the position and motion of the ball or other game related activity.

The automotive literature indicates that driver emergency response times are typically in the 1500 ms. (1.5 seconds) to 3500 ms. (3.5 seconds) range. Response includes the time to become aware from the potentially non-attentive state, identify the hazard/emergency, make a decision as to the initial course of action, and execute necessary body movements; typically to actuate a control such as the brake or steering wheel. The range in time published shows a significant variation, largely due to the variation in pre-event attentive state; i.e. vigilant versus non-attentive and complex verse simple reaction. This difference, 3500 ms compared to 1500 ms is more than 200%.

Early automotive research demonstrated the effect of “surprise” versus “prepared” “responses”. In one study, the mean brake application time for surprised test subjects was

nominally 750 ms. compared to nominally 500 ms. for prepared subjects; a difference of 50%. Clearly, there is a significant effect on human response time affected by the level of preparedness.

Another aspect of the automotive literature that may be of interest in this project is the response times of more “active” automotive drivers such as motorcyclist and riders of active type off-road vehicle operators. For example, in one research study, Thom (1981/1985) indicates that motorcycle operation using proper anticipation techniques showed brake application times less than 230-330 ms. less than half of earlier passenger car brake application response times in the 500 ms. ranges. Similarly, Fowler (1994) indicates the response of rider active off-road vehicles/operators to be nominally one-half that of passenger cars and their operators. These studies indicate that driver response time in situations involving more active/athletic individuals are significantly less than response times where the operators are not physically active; this (active) would be the situation for sports such as baseball.

Beyond the automotive literature, the literature review in this project was separated into three categories.

- Baseball focused- hitting or catching
- General human factors/physiological based
- Other sport/activity response times

The published literature reviewed regarding baseball response times did not reveal any studies that included real or near game simulations.

Cassidy/Burton (1997) reviewed the reaction literature and report that accurate responses may begin 125 ms. after ball contact and complete motion of the arm to the ball in at least 200 ms.; for a total response time of 325 ms. This response time does not consider the benefits that

would be gained by anticipation, proper technique, and being prepared to field/deflect the ball prior to ball motion being detected.

They report that the actual swing of the bat for the hitter begins 250 ms after the pitcher releases the ball; there are cues that allow batters to coordinate their action based on the motions of the pitchers. They summarize that reaction times ("RT") may decrease with increased ball velocity. An explanation of the faster RT is attributed to the role of auditory anticipation. This review indicates that fielding a baseball is not a standard RT situation, rather there are a number of cues available to fielders prior to the ball being hit; they recommend a minimum safe fielding time of ~325 ms. and speculate that pitchers may need longer. None of their findings are based on scientific studies involving actual game situations and do not address the benefits of anticipation or proper technique in reaction times.

Using a ball throwing machine a study was conducted of reaction time and movement speed by Williams/MacFarlane (1975). This study reports that RT for a simple situation is in the 150 ms. range, but can increase when the situation becomes more complicated. They conclude that there is no dependent correlation between RT and motion time (MT). It is discussed that both RT and MT can be reduced both through practice and anticipation. The test data shows RT of 148 ms. and MT 99 ms. (totaling 247 ms.) for ball speeds of 123 mph. A ball traveling an average speed 123 mph (180 feet/sec) will travel from the plate to the pitchers area in 300 ms.

Brandt (1998) conducted an experiment where fielders were stationed behind a net screen and balls shot at the players from varying distances measuring the available time based on ball speed/distance and the per cent of time the “shots” would have hit the test subject. His data for college baseball indicates that at 363 ms. subjects were successful more than 90% of the time, and for available time of 376 ms. the subjects were successful 100% of the time. This study

acknowledges that it does not account for real game situations where the fielder has other cues, such as the batter's swing, that would tend improve performance. The study suggests that this is cancelled out by the fact that in the testing the fielders were always concentrating, which may not be the situation in an actual game.

However, no data was presented to support this determination. Though there *may* be some pitches/hits during game situations where a fielder may be distracted, this is not the case for pitchers, who are by the nature of that position critically involved in every pitch. Pitchers are taught/coached to include a motion to a ready position a part of the follow-thru for every pitch. In addition, the effect of moving the pitching cannon closer than 50 to 60 feet from the test subject as a part of the test methodology can affect reaction time due to the depth perception effects that are critical in judging spatial issues.

A program for NCAA compliance under the direction of Crisco (1997) indicates that literature on the topic is limited and existing standards are based on practical experience with little scientific basis. In an evaluation to determine what time is necessary to avoid being impacted by a batted ball, the Cassidy-Burton review is cited with the total response time estimated to be 325 ms. This estimate indicates that batted ball velocities less than 115 mph would be judged as "Safe Batted Balls". In comparison, an empirical study by Greenwald, Penna, and Crisco, "Differences In Batted Ball Speed With Wood and Aluminum Baseball Bats; A Batting Cage Study", Journal of Applied Biomechanics, 2001, 17, 241-252, which measured the exit speed of balls hit off three regulation metal bats found that the highest performing metal bat at that time had an exit speed for the best 10% of its hits of approximately 106 mph.

Many authors have addressed the concept of anticipation as related to affecting reaction time. Schmidt (1968) considers the effect of fore-periods in anticipation's reduction of reaction

times; among the factor affecting beneficial anticipation is learning and the complexity of the tasks involved. Poulton (1950) shows mean reaction times of 150 to 200 ms. for simple and complex graded reactions respectively; with the effect of anticipation reducing the reaction to the 25 ms. range. Further Schmidt's (1977) research indicates that error correct reaction time may be 60 to 100 ms or longer; and may be affected by incorrect anticipation. Included in the anticipation literature are references that proper anticipation could reduce reaction time to zero.

The more fundamental oriented human factors based literature addresses some aspects of body motion, viewing/vision, and body motion. DeGoede/Ashton-Miller (2001) show hand motion times for young males that range from 226 to 283 ms; this study acknowledges that the MT could be less in higher threat conditions and the limitations due to experiment design in measuring the maximum capacity in lower threat situations. Crago (1976) shows that humans are capable of tracking fairly precisely force and displacements in the 100 ms. time range; latency times in the 60 ms. range were common. In similar research Johansson (1988) showed linear tracking between applied force and grip force in the 100 ms. time frame; concluding that motor responses are largely automatic.

In a study published by Owings, et al of the Cleveland Clinic Foundation (2003) an experiment was conducted to simulate the reaction and motion times to catch balls projected at the subjects. Players ranging in age from 8-16 years were included and placed at a distance ~45 feet from the ball throwing device, consistent with the distance from the mound to the plate for Little League, but a significantly shorter distance than in high school and college play. This study, similarly to the Brandt study, did not include game conditions or the effect of anticipation by the subjects as would be the case for pitchers in game settings. It should be noted that in the Owings study, events where the researchers felt the fielder anticipated, were deleted from the

data used for analysis. The study was conducted using two defined ball speeds and did not attempt to establish a limit on either ball speed or response time. This study also attempted to quantify glove speed in fielding efforts. The response time reported for attentive 14-15 year old males was 194 ms and 181 ms for 16 year old males. The assumption, however, was that players would have to move their gloves a distances equal to half their height, much greater than the distances we observed. Glove movement time was shown to be a function of ball speed (as was reaction time) and was 3.0 to 4.3 mm/ms for 14-15 and 16 year old males respectively.

A recent study by Nicholls et al from Australia (2005) represents an effort to simulate or computer model bat and ball interaction to predict ball velocities. The study indicates that there are factors in addition to bat material properties that affect Ball Exit Velocity ("BEV"); including the ball stiffness, trajectory and bat configuration. This study referenced the Owings study regarding reaction times but did not conduct any independent research regarding reaction time or motion times of pitchers or fielders. This study also identifies the importance of proper fielding and pitching technique in minimizing risk. It should be noted that the Nicholls study modeled a bat that is no longer permitted under the current regulations, and did perform any actual empirical research.

The human factors and baseball related literature clearly documents response times in the 200-300 ms. range; it does appear that complete response time less than 200 ms. for baseball type tasks are not common. Response times in the 325 to 367 ms. time frame have also been published from baseball; these are based on test methods that are limited in scope and do not address many issues related to game situations. In addition, these response times do not take into account in any systematic way the benefits from anticipation times that would be associated with game situations, especially as related to pitchers.

A review of literature and data from other sports serves to confirm that athletes routinely respond in similar time frames. For example, tennis ball speeds frequently approach 120 mph, a hockey puck can achieve speeds in excess of 118 mph, free kicks in soccer can approach 70 mph and likewise volleyball spikes can exceed 70 mph. Each of these sport events results in response times less than 300-400 ms.

In a Master's thesis Silva (NIU-1989) studied the reaction times of female volleyball players in various movement actions. The mean reaction time was less than 300 ms. for all conditions researched.

In summary, the literature clearly indicates that human response time including reasonable anticipation time for athletic tasks including pitching and fielding are very short. However, no literature was located that addressed the application of basic human characteristics or applications to baseball in game type situations from a testing or scientific standpoint.

Field Study

As a second phase in this project a study was conducted to measure on a scientific basis the response times of college level pitchers in game type situations. To accomplish this, active members of the baseball teams at Rollins College (Winter Park, Florida) and Stetson University (DeLand, Florida) were recruited. Included were pitchers, catchers, and hitters/fielders.

During December 2001, a series of "game" events were organized. The games consisted of a number of "innings". In each inning each pitcher threw 12 balls to 1-2 batters; the pitches were made both from a wind up and from a stretch. The game consisted of 9 innings; pitchers threw for 3 innings. The pitchers were instructed to "throw" balls as they would pitch in a regular game, but to generally throw strikes; as this was done in the off-season no curve balls were thrown. The batters, using aluminum bats, were instructed to try to hit the ball "hard up the middle" to the extent possible.

Each pitcher was given a dark jersey that was targeted with reflective targets denoting various body landmarks; in addition, a kayaking helmet was also used to provide a secure/fixed reference target on the pitcher's head. The game events were documented with various video cameras; a separate high speed, motion analysis based video camera system was framed on both the pitcher and batter; the system has a resolution time of 60 to 240 frames per second. Also in those framed views were synchronization lights that allowed precise visual tracking of the events in each field of view. Various control targets, field dimensions, and radar equipment to monitor pitch speed were also utilized for data control and verification. Pitches were charted recording batter/bat, and other aspects shown in *Attachment B* to monitor the number of pitches and hits.

In total, 7 "games" were conducted that involved 21 different pitchers. Games were played both during the daylight and at night, using stadium lights. Following the field study, the game films were reviewed. In total more than 700 pitches were recorded, from these ~70 hits were identified in which the pitcher either reacted to be an active fielder or moved to respond to a ball hit in his vicinity. Those events were selected for further motion and timing analysis. In those events a timeline was recorded from the game films.

The timeline included the following sequence:

- Flash of the timing light to sequence the pitcher and batter reference frames
- Pitcher's release of the ball
- Contact between the bat and ball
- First motion of the pitcher to respond to the ball
- Arrival of the ball into the pitcher's area

The arrival of the ball into the pitcher's area was not visible in all events as the path and trajectory of the ball on some occasions traveled beyond the frame of high speed motion video.

In all identified events the pitcher did respond to the batted ball in sufficient time so as to either catch/deflect/field the ball or be in a position to catch/deflect/field the ball in events where the ball was outside the pitcher's zone. It was noted that the pitcher's response time was dependent on the speed of the ball coming to his area. In events where the ball came slower the pitchers responded accordingly; in events where the ball was traveling faster the pitchers responded faster. The speed of the pitched ball ranged from ~65 to ~90 mph.

Analysis of these events using motion analysis software/video determined that the mean initial response time was 176 ms. This is the time from the point of contact between the bat/ball and first visible motion of the pitcher to respond to the ball; in previous literature this has been referred to as latency time.

Due to the fact that the pitchers clearly responded to what the situation required, the quickest response time for each pitcher who had more than one identifiable response was analyzed. When looking at these response time events, the average initial quickest response time was 143 ms; with the quickest being in the 33 ms. range. Those events were then analyzed to determine the position of the pitcher 300 ms following the ball/bat contact, as is suggested in the literature.

An analysis of those positions indicated that in each event, the pitcher was in a position that would permit him to avoid or deflect a ball in his direction at 300 ms after ball/bat contact. This corresponds to an average exit speed of 123 mph, substantially greater than what has been estimated off of any bats.

Game Film Analysis

Actual game films (videotapes) were obtained and reviewed for 16 college level games. Each of these films was reviewed; ~65 events where pitchers reacted to batted balls in their direction were identified. These events were analyzed using standard video equipment with

resolution to 60 frames per second (30 scans per second, 2 frames per scan). Similar to the field study the events were analyzed to determine the latency time, the time from the ball/bat contact to first response motion by the pitcher. The average latency time from these events was 182 ms. Of note is that the average latency time from the field study was 176 ms, and previously cited references showed latency times of 100 to 200 ms. The shortest latency time observed in these game condition events was less than100 ms.

For pitchers that had more than one identified event, their quickest response was analyzed similar to the analysis described in the field study. The average initiation of response time for those events was 151 ms; again comparable to the field study average of 143 ms.

The field study and game film analysis confirms that the initial response time (latency time) for pitching events is in the 150 ms range; consistent with what was shown in the literature. The field study and game film analysis are also consistent with a response time of 300 ms to avoid, deflect, or field batted balls.

As in the field study, since catching a ball involves the timing between the ball and the glove being at the same place in space at the same time, pitcher response time varied according to the batted ball speed. In all of the events the pitcher’s response time was sufficient so as to be in position to adequately respond. An analysis of the events that required generally quicker response times showed that pitchers were able to begin response motion (latency time) and be in a position to avoid/deflect/field the batted balls within 300 ms.

The pitch, hit, respond sequence is an event that is a key part of the game of baseball. This is a sequence that can be modeled from a time/task standpoint involving the interaction between the pitcher and batter (Figure A).

Figure A

Simplified Pitcher-Batter Hitting Tasks Analysis

Pitcher	**Batter**
Assumes Position on Mound	Assumes Position in Batter's Box
Determines Pitch to be Thrown	Sets Feet and Cocks Bat
Begins Wind-up	Focuses on Pitcher
Releases Ball	Observes Ball in Flight
Assesses Pitch	Determine Swing (yes/no)
Follow-thru to Ready Position	Begins Swing Motion
Sees Batter Start Swing	Swings Bat
Sees Batter's response	Hits Ball or Misses
Sees/Hears Hit	Completes Swing
Responds to Ball	Follow-thru

Each aspect of the batting and pitching tasks involves developing the proper technique to allow the player to enhance their performance. Included is learning to look for cues that give the player an opportunity to be prepared more accurately for the next task. For example, batters are coached to watch the motion of the ball off of the pitcher's fingers to better allow them to anticipate the type of pitch being thrown so that swing adjustments can begin earlier in the sequence.

In analyzing this model there are several key components that relate to pitcher response times;

- Both the pitcher and batter anticipate and benefit from cues that allow them to improve their performance. For example, a pitcher knows when a pitch can possibly be hit the instant it leaves his hand. This is confirmed when the batter starts to

cock the bat in preparation for the swing. Generally, the pitcher can hear the contact between the ball/bat with greater precision than he will be able to identify visually. The time for the sound to travel to the pitcher is on the order of 5 ms.

- Pitchers using proper technique develop as a part of their wind-up and follow thru a motion that immediately flows to place them in a ready to field position. There are instances where the pitcher does not follow this approach and in these instances may impact his response motion. Proper coaching and practice should include developing proper technique as a part of every pitch.

- There is a significant difference in the task requirements to field batted balls in the pitcher's direction if the essential goal is to deflect or avoid the ball, rather field the ball error free. The deflection/avoidance task is far more direct and requires less precision, resulting in less time demands.

- Due to the nature of the game the fore-period between pitch events is generally short and in control of the pitcher. This enhances the pitcher's attention, focus and reduces response times compared to that of other positions.

Consequences of Pitcher Error

The foregoing discussion reflect situations where the pitchers were prepared, using proper technique, and includes utilization of reasonable anticipation time. Obviously, errors (mistakes) occasionally occur. But recovery from such errors (mistakes) will take more time than would be available from any alleged difference between wood and aluminum bats. As the literature above indicates, delays or incorrect initial responses can easily extend the overall response time by 100 ms. or more.

The Greenwald, Penna, and Crisco study cited above compared pre-regulation metal bats to the top 10% of wood bats, and found an 8 mph difference between the exit speed of the top 10% of hits off one pre-regulation metal bat and the top 10% of hits off wood bats. An 8 mph difference in batted ball speed would not be significant in the ability of the pitcher to avoid a batted ball, as the time difference (26.67 ms) is a small fraction of the recovery time a pitcher would require. In fact, 26.67ms (2.6% of a second) is a very small period of time, approximately

the same time it takes for a hummingbird to flap its wings. Thus, if a pitcher made an error, even if metal bats hit 8 mph faster than wood bats, this would not meaningfully alter the pitcher's ability to recover and avoid an impact.

Findings

Based on the above referenced research the following conclusions are offered at this time:

a. The field study conducted using game type conditions and the review of actual college level game films indicates that pitchers respond within 300 ms to a ball batted in their direction.

b. All of the available scientific data is consistent with the conclusion that an attentive, in-position college level pitcher using proper technique will be able to respond within 300 ms. to a ball batted in his direction. This provides the pitcher with sufficient time to respond to batted balls traveling at more than 120 mph, more than is alleged to occur from any non-wood bat.

c. If a pitcher makes a mistake, the additional time available attributable to the difference in batted ball speed between wood bats and a pre-regulation metal bat will be only about 2.6 % of a second, which is not sufficient to enable the pitcher to avoid injury.

I declare under penalty or perjury that the foregoing is true and correct.

This 29th day of May, 2007.

Kevin Breen

ATTACHMENT A

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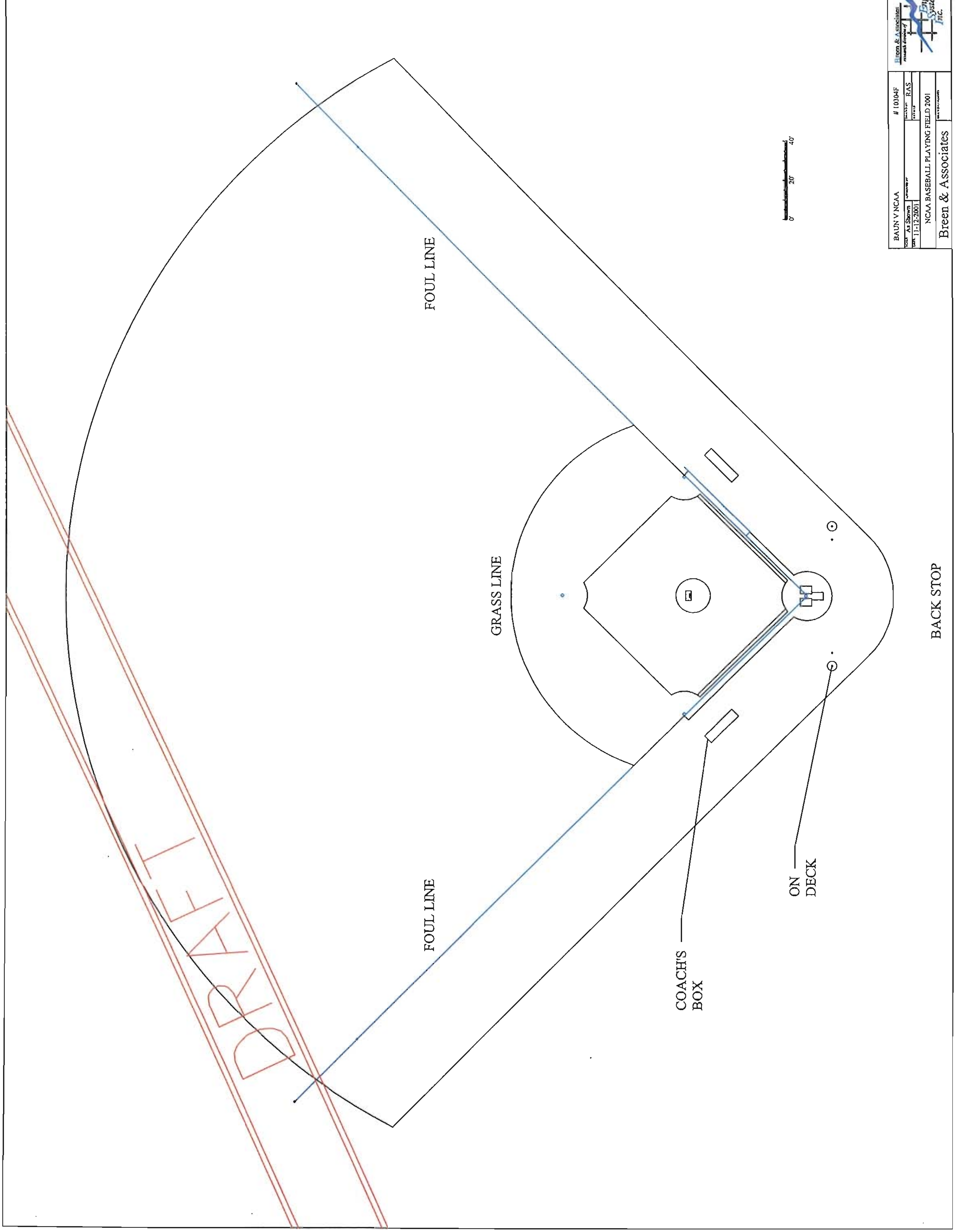
ATTACHMENT B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11-12-2001
NCAA BASEBALL PLAYING FIELD 2001
Breen & Associates
Engineering Systems Inc.

TIME GAME BEGINS: ____________________ DATE: ____________________

TIME GAME ENDS: ____________________ LOCATION: ____________________

VIDEO NO.	INNING	BATTER/ PITCHER ID	BAT ID	PITCH COUNT	RADAR SPEED (MPH)	BATTER SWING (Y/N)	CONTACT (Y/N)	HIT LOCATION FOUL L	M	R	FAIR L	M	R	PITCHER RESPONSE REACT (Y/N)	HIT (Y/N)	DEFLECT (Y/N)	FIELD (Y/N)	COMMENTS
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Batter Document Sheet

Initials:

Session:

Age:

Height:____________ Weight: ____________

Bats: Left / Right

Initials:

Session:

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Bats: Left / Right

Initials:

Session:

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Height:____________ Weight: ____________

Bats: Left / Right

Pitcher Documentation Sheet

Initials: ______________________

Session: ______________________

Age: _______________

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Left / Right Handed Statrer / Reliever

Years Experience: _____________

Ruler Drop: ________________________________

Marker Sets:

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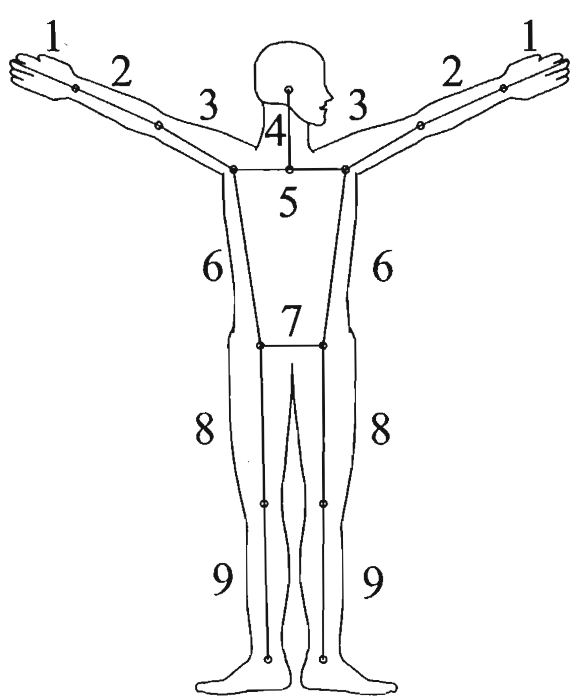

Left

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Breen & Associates
research division of
Engineering Systems Inc.

Rollins College


ST. JOHN CLUB
DELCO OIL INC.
MORGAN STANLEY DEAN WITTER
STETSON
Florida's First Private University
BOULEVARD TIRE CENTER
Comfort Service
TENNANT PRINTING COMPANY
Sullivan DODGE

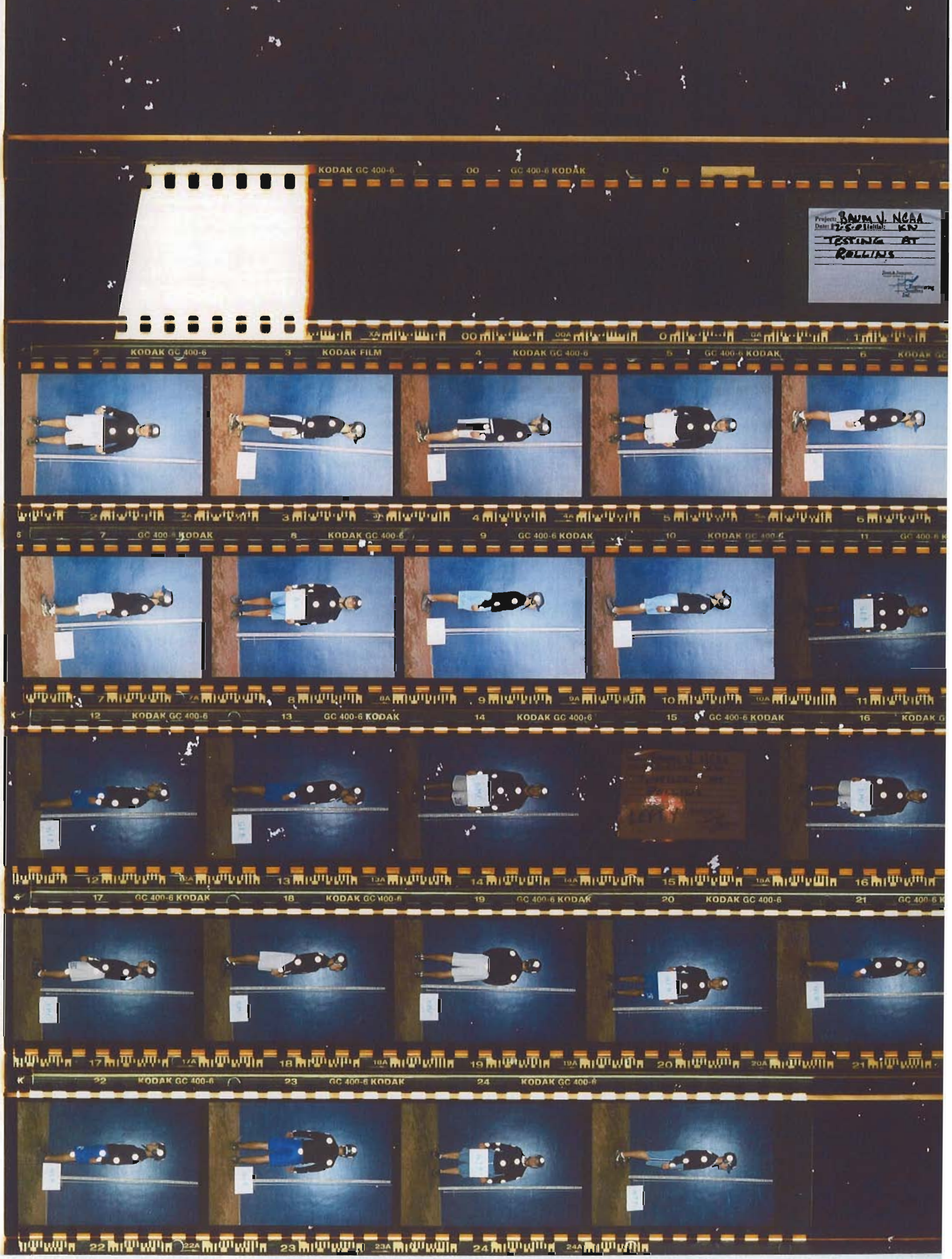

GUEST
325
GO TARS!


Tars

Stetson University


EASTON


BAUM v. NCAA
KN
TESTING AT
RAWLING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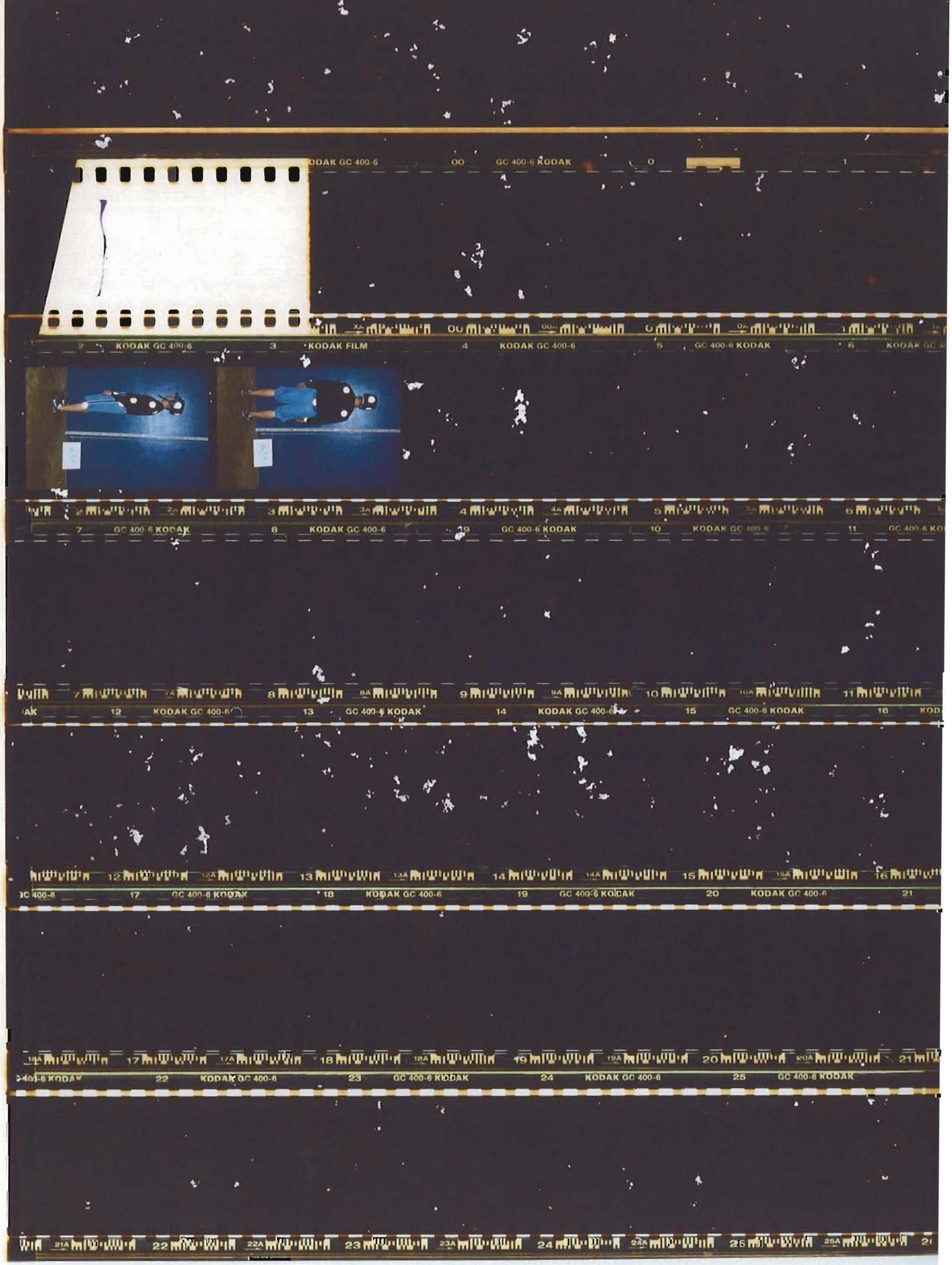
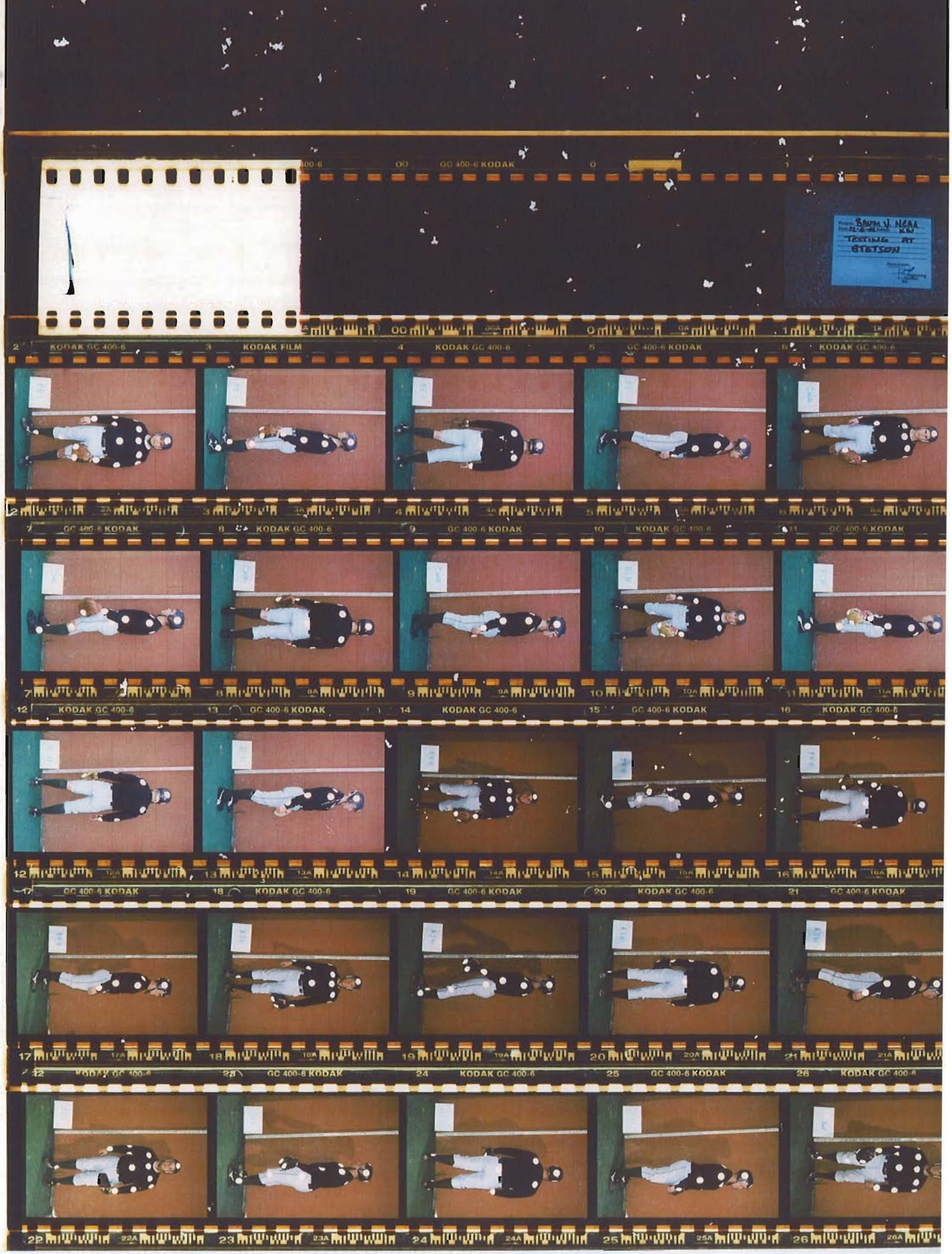
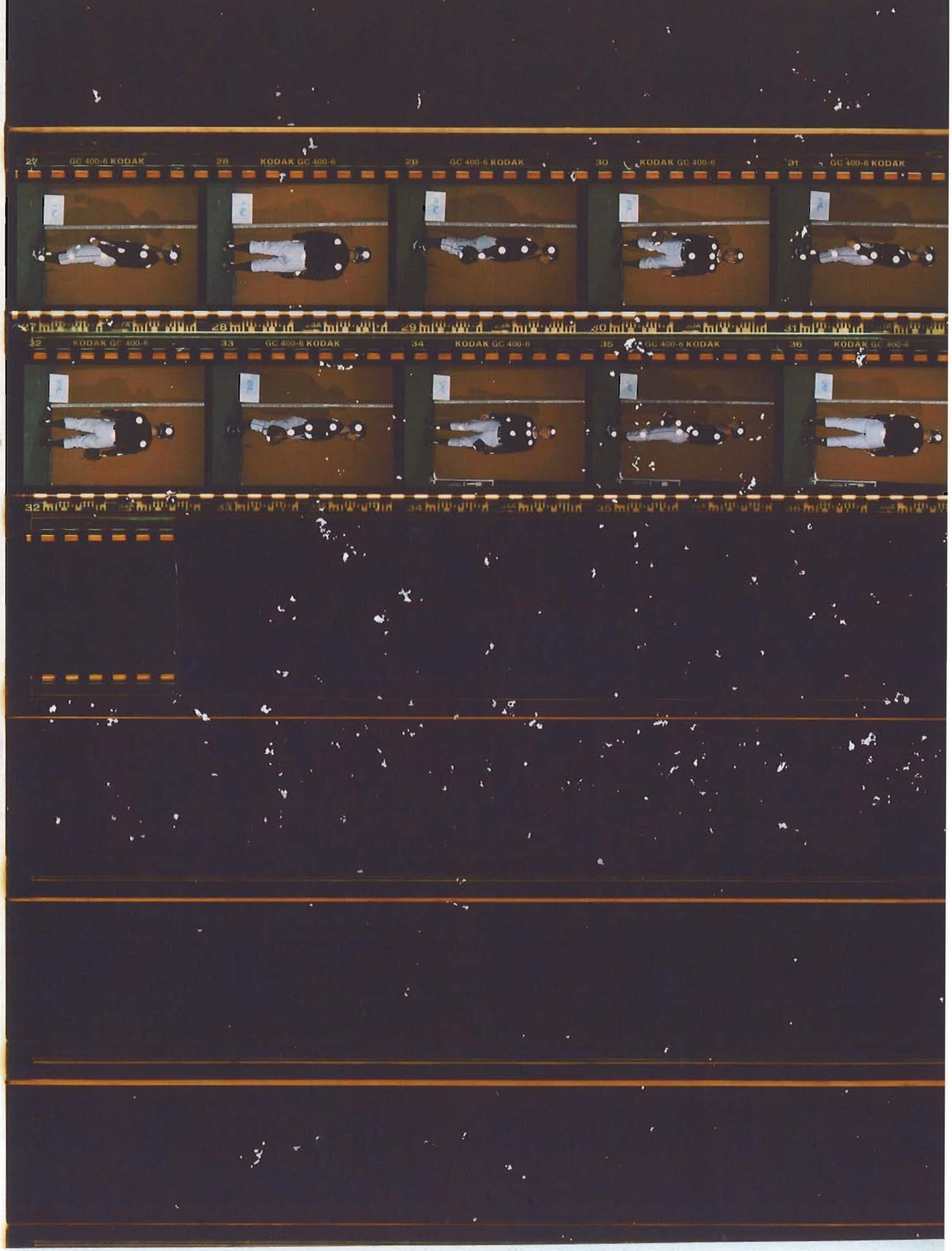
TESTING AT
ROLLINS
KODAK GC 400-6




BAUM V. NCAA
TESTING AT
STETSON
KODAK GC 400-6
KODAK FILM


27 GC 400-6 KODAK
28 KODAK GC 400-6
29 GC 400-6 KODAK
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31 GC 400-6 KODAK
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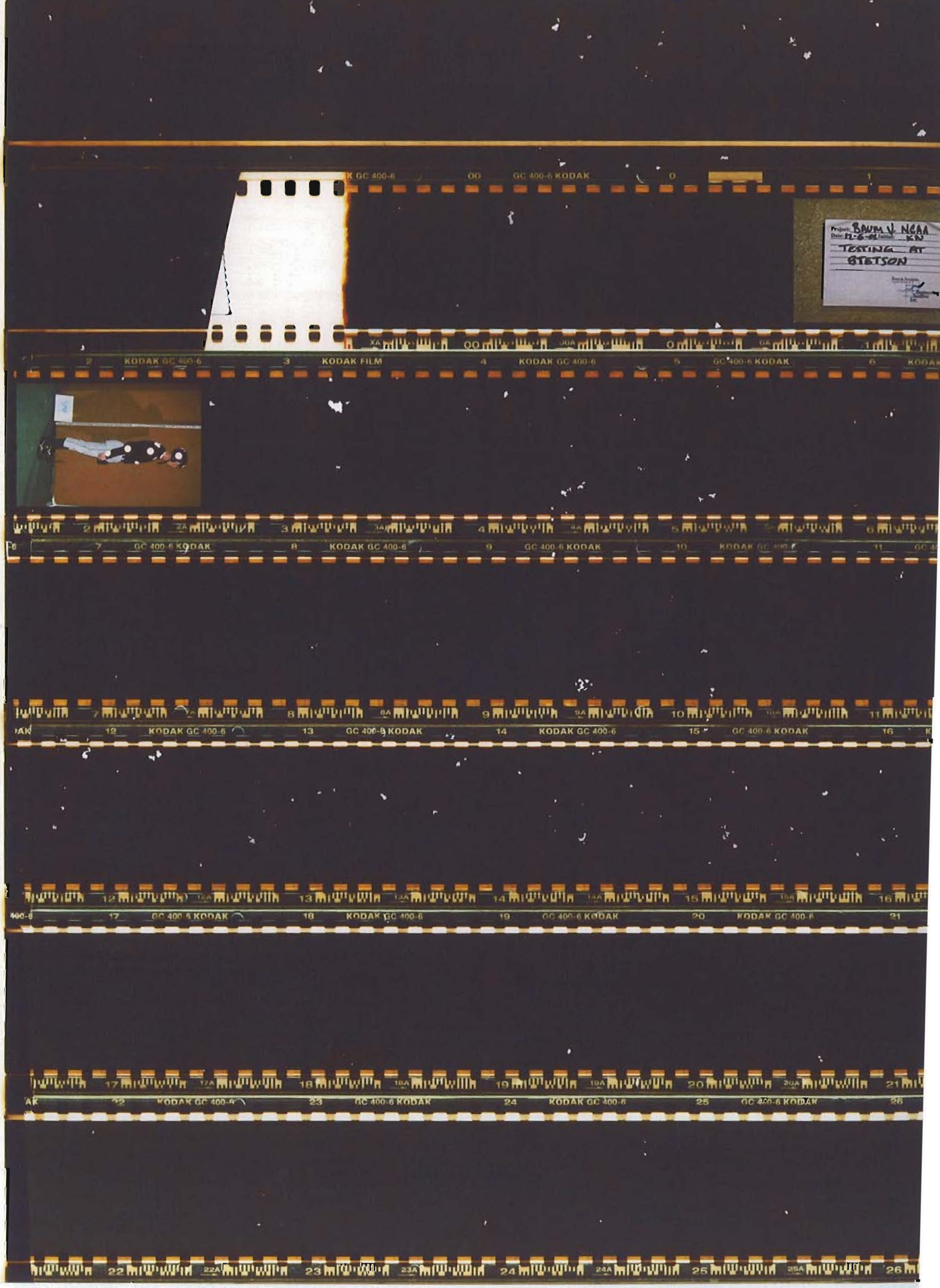
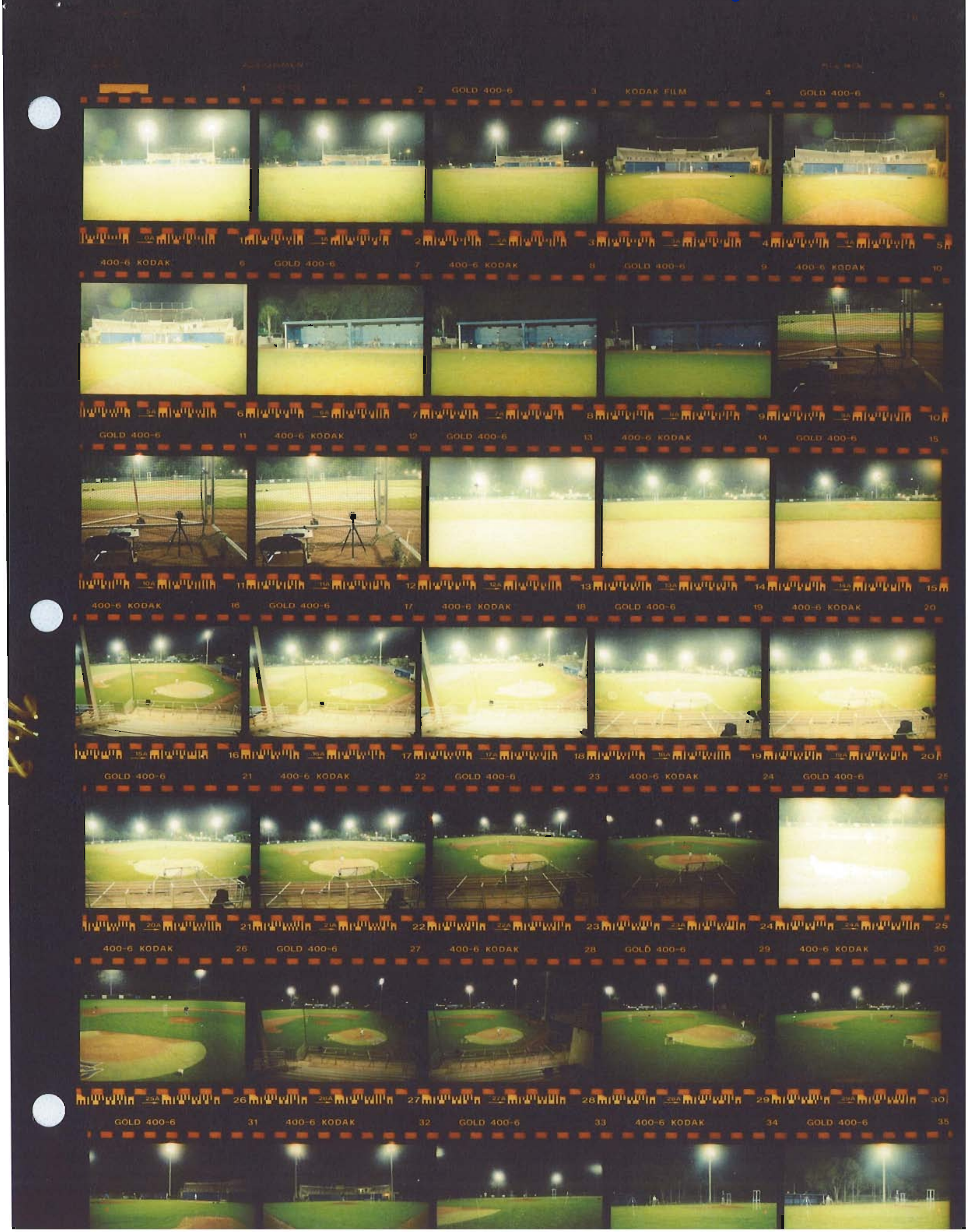
34 KODAK GC 400-6
35 GC 400-6 KODAK
36 KODAK GC 400-6


BAUM V. NCAA
TESTING AT
STETSON
KODAK GC 400-6
KODAK FILM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33 100-6 KODAK
34 GOLD 100-6
35 100-6 KODAK

ATTACHMENT C

Reviewed Games List

Alabama v Miami

Rice v Oklahoma

USF v Miami

Tennessee v Miami

Miami v FIA

Duke v ASU

Miami v Minnesota

FIU v Miami

Tampa Bay v Rollins College 1998 World Series

Rice v Purdue

UCF v Purdue

Wake Forest v Purdue

San Jose State

San Jose State

Gomes Tape